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Preliminary communication

DETERMINANTS OF NON-PERFORMING LOANS AND THE RELATIONSHIP WITH MACROECONOMIC FACTORS: EVIDENCE FROM SOUTHEASTERN EUROPE

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Abstract

Despite significant progress in this area, the problem of non-performing loans continues to receive central attention in the banking systems of the SEE countries after the 2008/2009 crisis, reducing the profitability and resource utilization of banks. The purpose of this paper is to investigate the determinants of non-performing loans and their effect on the macroeconomic situation in Southeast Europe. First, in order to test the relationship between credit risk and certain balance sheet and macroeconomic indicators, we create a model that uses annual panel data for 5 Southeast European countries for the period 2008-2017. The results show that profitability has a negative impact on nonperforming loans, while credit growth and capitalization rate have a positive and statistically significant impact on the nonperforming loan portfolio. The second part of the econometric analysis consists of examining the cointegration, i.e. long-term and short-term relationships between non-performing loans and macroeconomic variables. The results imply that in conditions of higher unemployment, slower economic growth and falling prices, credit risk increases in the long run. Such conclusions are robust when using alternative valuation methods on the long-term relationship. However, in the short run, only GDP has an inverse statistically significant relationship with nonperforming loans, while unemployment and inflation have proved to be statistically insignificant, although the relationship between them and nonperforming loans has the same direction as in the long- run model. Such conclusions are generally consistent with both the theory and the numerous studies that have been done on this topic.

***Keywords**: Non-performing loans, macro financial linkages, Southeast Europe, econometric modeling, panel analysis.*

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1. Introduction

In the last few decades, non-performing loans have been a challenge for developed, as well as developing countries, both between researchers and regulators. Numerous researches on the causes of bank failure find that asset quality is a statistically significant predictor of insolvency, (such as Dermirgue-Kunt 1989, Barr and Siems 1994) and that failing banking institutions always have a high level of nonperforming loans, right before they fail. Moreover, experience shows that nonperforming loans are the reason for the banking system instability and financial crises that lead to economic stagnation. Therefore, in recent years, there has been an increasing number of studies analyzing credit risk, with attempts to identify the factors that influence its occurrence, as well as the links between credit portfolio quality, macroeconomics, and the idiosyncratic nature of banking activities.

Past studies that focus on analyzing the effects of macroeconomic variables and bank-specific determinants on the level of non-performing loans often overlook the differences between countries. In doing so, they focus on a single banking system and the consequences of changes in macroeconomic conditions, as well as specific indicators of financial stability. They generally focus on identifying the relationships between credit portfolio quality and macroeconomics, banking or financial systems, individual bank behavior, or all three segments together. Almost all of them are divided into two groups: first in terms of the dependent variable that expresses credit risk, and second, in terms of explanatory factors on which the level of credit risk depends. When it comes to the dependent variable, different authors define credit risk differently.

The paper is organized in the following way: the next section is a brief review of the existing literature, along with some stylized facts on the chosen sample of countries. The following section discusses the econometric methodology and the data used, after which the results and findings of the long-run and short-run estimates are presented. Finally, conclusions are provided.

2. Literature review

Given the dominance of loans in banks' assets, credit risk is the most important type of risk, whose realization manifests itself in the growth of nonperforming loans, which may threaten financial stability and consequently, economic activity.

The literature on credit portfolio quality and its relation to certain bank-specific variables and to macroeconomics is extensive. However, the research on the determinants of credit risk has increased the interest of researchers in the period after the global financial crisis of 2007-2008.

The study by Keeton and Morris (1987) is among the first studies of the factors affecting nonperforming loans, which is based on a survey of a sample of 2470 commercial banks in the United States from 1979 to 1985. The conclusions reached are that the

most important factors explaining the variations in credit losses between banks are the local economic environment, some low-efficiency industries, and the differences in risk-taking by banks.

Salas and Saurina (2002) review the determinants of credit risk in Spanish commercial banks, by analyzing both bank-specific and macroeconomic data from 1985 to 1997. According to them, variables that explain credit risk are economic growth, household and corporate debt, credit growth, inefficiency, portfolio structure, size, net interest margin, solvency and market power.

Louzis et al. (2010) examine the impact of macroeconomic and bank-specific determinants on nonperforming loans in the Greek banking sector. Their study covers the analysis of the nine largest banks using quarterly data for the period 2003Q1 to 2009Q3. Their findings indicate that GDP growth has a negative impact on the growth of all types of non-performing loans, while unemployment and the key interest rate on loans have a positive impact. From bank-specific determinants, the ratio of loans to deposits has a statistically significant negative impact on the growth of nonperforming loans, while solvency has a positive effect on the growth of nonperforming loans to enterprises, while its impact on mortgage loans is negative.

Bofondi and Ropele (2011) examine how macroeconomic determinants affect the quality of the credit portfolio of the Italian banking system over the period 1990Q1-2010Q2, using aggregate data by applying a simple linear regression model. As a dependent variable in their model, they use non-performing loans, at household and corporate level. Their results suggest that growth rates of real gross domestic product and house prices have an inverse impact on nonperforming loans to households, while the unemployment rate and the nominal interest rate have a positive impact. Regarding companies, nonperforming loans are increasing as the unemployment rate and the key interest rate increase, whereas they decrease as consumption of durable goods increases. The above macroeconomic determinants affect nonperforming loans with a different time lag.

Klein (2013) analyzed NPLs in CESEE (Bulgaria, Bosnia and Herzegovina, Hungary, Croatia, Czech Republic, Estonia, Latvia, and Lithuania) for the period 1998–2011. In his research, he used three alternative estimation techniques, among which the fixed-effect model, difference GMM, and system GMM. This study provided evidence that NPLs respond to macroeconomic conditions, such as GDP growth, unemployment, and inflation.

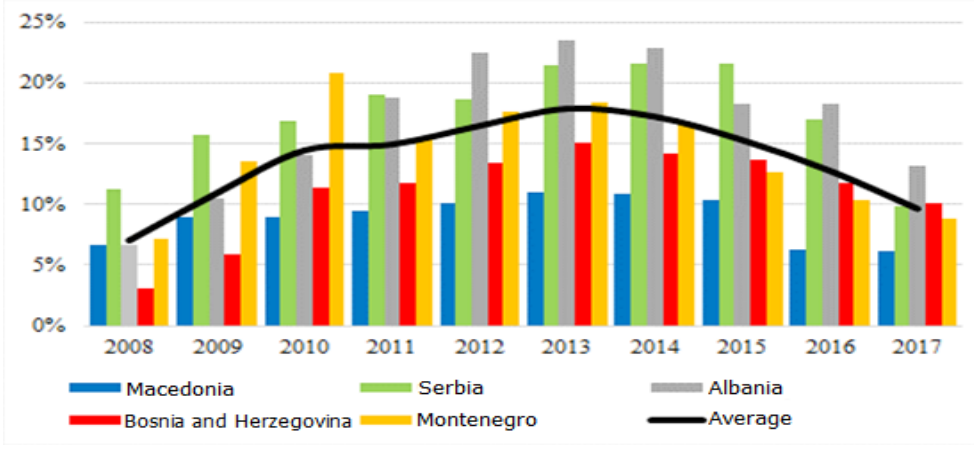
3. Current trends and conditions

Before the global financial crisis, the banking sector in Southeast Europe experienced a credit boom. The main driver of credit growth was the high demand from the private sector, households, and non-financial entities. Thus, the average annual credit growth rate in the period 2003-2008 was 22.1% for Bosnia and Herzegovina, 30% for Macedonia, 37.3% for Serbia, 47.6% for Albania and 77.9% for Montenegro.

However, the onset of the financial crisis had a huge impact on credit growth, contributing to significantly lower credit growth rates, along with the worsening of the credit portfolio. High level of non-performing loans has become a limiting factor during the crisis and has grown into a systemic risk for countries in Southeast Europe.

At the end of the analyzed period, in 2017, the highest rate of non-performing loans was noticed in Albania (13.2%), followed by Bosnia and Herzegovina (10%), Serbia (9.8%), Montenegro (8.8%). %) and the lowest rate was recorded in Macedonia (6.1%). With the exception of Serbia, from 2013 onwards, the share of nonperforming loans to total loans follows a downward trend in the analyzed countries. Only in Serbia the rate of nonperforming loans has continued to grow since 2008, until 2015, when there was a change in the upward trend. Bosnia and Herzegovina started the crisis with the lowest level of non-performing loans (3.1%), twice lower than the rate among the analyzed countries, except for Serbia, which had almost three times higher rate of non-performing loans than Bosnia and Herzegovina in 2008 (11, 3%). Montenegro experienced the fastest growth rate since the crisis, by 6.3 and 7.3 percentage points in 2009 and 2010, respectively, while in Macedonia, on the other hand, bad loans grew at a slower pace and their share in total loans was consistently below the average for these countries during the analyzed period.

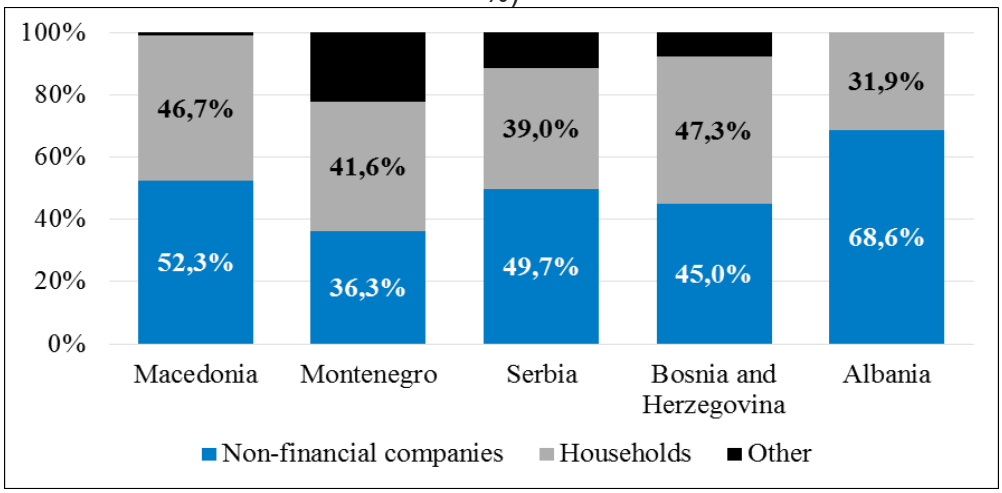
Figure 1. NPL, by country (in %)



Source: Author's calculations.

At the end of 2017, the structure of the loan portfolios of the analyzed countries shows different tendencies of banks for lending to households and the corporate sector. In Serbia, Macedonia and Albania, corporate loans dominate the structure of total loans, while in Montenegro and Bosnia and Herzegovina, household loans and corporate loans have almost the same share, with slightly higher share of household loans. In Albania, more than two-thirds of total loans are intended to support the corporate sector.

Figure 2. Sectorial structure of total loans, by country, as of 31.12.2017(in %)



Source: Author's calculations.

Table 1 presents descriptive statistics for the selected variables used in the construction of the regression model. It is evident that in the analyzed period, the level of non-performing loans in the selected countries of Southeast Europe is quite high (more than 13%). Of the other variables analyzed, the average rate of return on equity was about 4%, and the ROAA was 0.5%. From the macroeconomic variables, the unemployment rate was over 21%. The average inflation rate was around 3% and GDP grew by almost 2% on average during the analyzed period.

Table 1. Descriptive statistics of the variables

	NPL	GDP	INF	UN	ROAA	ROAE	GROSS_LOA...	C_A
Mean	13.63766	1.939023	2.847996	21.32580	0.509016	3.770135	160414.7	13.10833
Median	13.33300	2.560947	2.082472	19.69500	0.660185	4.852322	15470.56	11.33685
Maximum	23.50000	7.222796	12.41099	33.80000	2.137348	15.70927	600875.6	23.64000
Minimum	3.091000	-5.795099	-1.251444	12.54000	-2.800000	-27.30000	1027.581	8.372028
Std. Dev.	5.173527	2.450777	3.160348	6.006781	0.862720	7.562744	216996.4	4.183778
Skewness	0.151923	-0.845236	1.183665	0.340929	-1.402701	-1.796595	1.030147	0.986622
Kurtosis	2.107977	4.096274	3.988740	1.967769	6.904346	8.116728	2.524598	2.743708
Jarque-Bera	1.850057	8.457321	13.71220	3.188397	48.15458	81.44151	9.314205	8.248711
Probability	0.396520	0.014572	0.001053	0.203071	0.000000	0.000000	0.009494	0.016174
Sum	681.8829	96.95116	142.3998	1066.290	25.45081	188.5067	8020735.	655.4164
Sum Sq. Dev.	1311.504	294.3090	489.4021	1767.989	36.47001	2802.559	2.31E+12	857.6959
Observations	50	50	50	50	50	50	50	50

Source: Author's calculations.

4. Methodology and data

The purpose of this paper is to examine the factors that influence non-performing loans in Southeast Europe. The extensive empirical literature contains evidence that data on both aggregate and bank level were used in such similar studies. Namely, aggregate data were used by Rinaldi and Sanchis-Arellano (2006) to overcome the

problem of data inaccessibility by individual bank for the euro area. According to Boudriga, Taktak, and Jellouli (2009), aggregate data for the entire banking system for each country are considered to be better, as the risk of non-representativeness of the sample is reduced, as opposed to using data per bank. For this reason, this study uses only data at aggregate level to determine which determinants affect non-performing loans and the relationship with macroeconomic variables. An additional argument for the use of aggregate data is that we conduct our research on several SEE countries, so data on the variables used in the analyzed period are not available per bank for all banks in the analyzed countries, but are available as time series at the banking systems' level instead.

The data used are extracted from the websites of the central banks of Macedonia, Serbia, Bosnia and Herzegovina, Albania and Montenegro, as well as from the databases of the International Monetary Fund (IMF) and the World Bank.

The used sample consists of a balanced panel of 5 countries (Macedonia, Serbia, Albania, Bosnia and Herzegovina, and Montenegro) with 50 observations for the period from 2008 to 2017. According to Hsiao (1986), panel data provide some advantage over other data, implying that individual countries are heterogeneous, they provide more information, are more efficient, allow greater variability and less collinearity among other variables, and offer the basis for constructing more complex models. At the same time, using panel data increases the sample, while gaining perspective for different countries.

For our dependent variable, we use the NPL ratio, i.e. the share of nonperforming loans in total gross loans. This ratio has been used as a measure of credit risk in numerous past studies. The independent variables can be divided into two groups: macroeconomic and bank-specific variables. Macroeconomic variables include GDP (real growth rate), unemployment rate, and inflation rate. According to Nkusu (2011), the effect of the inflation rate on the loan portfolio quality may be ambiguous, thus, the effect on nonperforming loans can be either positive or negative.

Regarding bank-specific variables, the rate of return on average assets (ROAA) and the rate of return on average capital (ROAA) were used as indicators of banks' profitability.

Further, the variable for credit growth reflects the general conditions of the credit market, i.e. it indicates the availability of loans. This variable indirectly indicates the degree of risk aversion by banks. The effect of credit growth on nonperforming loans can be in both directions. Jimenez and Saurina (2006) argue that rapid credit growth results in lower credit standards, which later manifest themselves in higher problem loans. On the other hand, Swamy (2012) finds a negative association between these two variables. Therefore, aggressive credit expansion does not always coincide with reckless risk-taking.

The capital to assets ratio is used as a measure of the financial leverage, i.e. the extent to which funds are funded from other sources. Klein (2013) provides evidence

of the negative association of the capitalization rate with nonperforming loans. These findings practically confirm the "moral hazard" hypothesis discussed by Keeton and Morris (1987). Other studies that confirm the negative relationship between the capital to assets ratio and nonperforming loans are those of Berger and DeYoung (1997) and Salas and Saurina (2002). However, Rime (2000) in his panel survey of Swiss banks from 1989 to 1995 finds evidence of a positive significant relationship between changes in equity and changes in risk.

5. Econometric modeling of non-performing loans

Given the empirical research on non-performing loans, we apply a dynamic panel GMM model in this paper in order to evaluate the effects of bank-specific and macroeconomic variables on non-performing loans in the selected SEE countries.

Prior to any estimations and modeling, we expect that GDP and inflation should have a negative relationship with the level of credit risk, while unemployment should have a positive relationship. In regard to bank-specific variables, we expect that profitability indicators will have a negative relationship with the level of non-performing loans. Due to the correlation between ROAA and ROAE, which is expected since net profit is a component of the calculation of both indicators, we omit ROAA in our model. On the other hand, we expect that credit growth and capital to assets ratio will positively affect NPLs. In addition, we include a dummy variable (DUMMY_2009), which has a value of 1 for 2009 and zero for the rest of the years, to capture the effect of the global economic crisis on the level of non-performing loans. According to Bucevska (2011), the crisis in the Republic of Macedonia started to be felt in the second quarter of 2009. Consequently, we included this variable in our model.

The starting point for the underlying model that links the level of credit risk with macroeconomic and financial indicators is presented with the equation in the following form:

where t and i refer to the time dimension and cross-section of the panel, respectively. u_{it} is the random error that includes all other factors that affect the level of non-performing loans that are not taken into account with this model. β represents the coefficient vector for the explanatory variables, and the X stands for the vector for the independent variables (in this case, those are real GDP growth (GDP), unemployment rate (UN), inflation rate (INF), credit growth (LOG(GROSS_LOANS)), ROAA and ROAE and capital to assets ratio (C_A)).

For robustness purposes, we evaluate the panel above first with the OLS method and then the difference GMM follows. Even though the diagnostics of the estimated OLS model shows that the residuals are normal and not serially correlated and the adjusted R^2 is quite high (78.4%), still we proceed to an estimation of a dynamic panel model. We include the first lag of non-performing loans in the model, in order to capture the persistence of non-performing loans, by applying Blundell and Bond's system generalized method of moments (Blundell and Bond 2000). We choose this

method of estimating the econometric model, because when we include dynamics in the model, that is, we include the dependent variable with a time lag, then the OLS method (ordinary least squares) gives biased and inconsistent estimates. The OLS method becomes inadequate because of the correlation between the random error and the time lag of the dependent variable, which would be solved as a problem when the sample is large enough, but in this case, to overcome it, Arellano and Bond (1991) technique is applied, known as the Difference GMM method with specification of instrumental variables. The main reason for choosing this technique is to model the dynamics of the dependent variable while taking into account the endogenous nature of some of the explanatory variables. Thus, in the equation we estimate, we also include the first lag of nonperforming loans, presented in the following form:

$$NPL_{it} = \alpha NPL_{(it-1)} + \beta X_t + \upsilon_{it}$$

where NPL_{it-1} is the first lag of nonperforming loans, with the coefficient α expected to be positive but lower than 1.

The errors of the estimated model are normal and the Arellano-Bond AR (1) and AR (2) autocorrelation tests cannot reject the hypothesis that the errors are not autocorrelated at both, first and second order. Moreover, the Jarque-Bera test indicates acceptance of the null hypothesis of normally distributed errors, which implies that the estimated coefficients are consistent and efficient.

Overall, the estimated models (both the OLS and the difference GMM) meet the a priori expectations and explain well the impact of the selected financial and macroeconomic indicators on non-performing loans in SEE countries. They confirm that the selected determinants have a certain impact on the quality of the loan portfolio.

When modeling non-performing loans with the GMM in differences, one can clearly see the justification for including the first lag of nonperforming loans. Namely, the model confirms the previously expected feature of non-performing loans to persist in the banks' balance sheets, which is a clear signal of their lack of management. Further, the capital to assets ratio proved to be significant and positively correlated with the level of credit risk in the SEE countries. This implies that banks in the analyzed panel adjust their capital positions accordingly with each increase in the risk taken. In addition, increased credit support is later manifested as increased credit risk. Additionally, ROAE, as a measure of profitability, has the expected sign and significance at the level of 1%. In spite of the significance of these variables, in this model, the macroeconomic variables proved insignificant at the level of 1%, 5% or 10%, despite having the expected sign. Finally, the dummy variable for the effect of the global financial crisis becomes significant at the level of 10% for 2010, that is, although initially, the economic crisis began in the United States in September 2007, the spillover effect into the SEE countries was felt in 2010.

Thus, the results suggest that the non-performing loans from the previous year, the share of capital and reserves in total assets and gross loans have a statistically significant positive impact in the SEE countries. Therefore, their one percent increase

would lead to an increase in the NPL ratio by 0.44%, 1.3%, and 4%, respectively. These findings of the persistence of non-performing loans in the banking system are in line with the research of Lee and Rosenkranz (2019) and Kjosevski and Petkovski (2017). Furthermore, capital adequacy, expressed through the capital to assets ratio, has been positively related to the non-performing loan portfolio, which is in line with the empirical evidence provided by Rime (2000). Therefore, we provide evidence in support of the hypothesis that banks with higher capital adequacy typically engage in riskier credit engagements, setting the stage for future higher levels of non-performing loans. According to Kjosevski (2016), this result is related to the fact that shareholders exert some "pressure" on bank managers to increase profitability, after which managers take a greater risk. Finally, the effect of credit growth has been positive and statistically significant, confirming the conclusion that looser credit standards in the periods of credit expansion, in order to achieve greater market share, contribute to the increase of the non-performing loan portfolio. Jimenez and Saurina (2006) and Keeton and Morris (1987) provide evidence in support of the argument that excessive lending leads to higher non-performing loans.

On the other hand, if ROAE increased by 1%, nonperforming loans would decrease by 0.29%, which implies that profitability, expressed through ROAE, is negatively correlated with the level of credit risk, which corresponds to the empirical results of Nikolov and Popovska-Kamnar (2016) and Espinoza and Prasad (2010). The global financial crisis has proved to be a significant determinant of nonperforming loans, as it was expected; it had an effect on the deterioration of bank loans.

Only macroeconomic variables, GDP, inflation rate, and unemployment rate proved to be statistically insignificant, although with the expected sign. A possible reason for this insignificance is that they are analyzed at levels, so if they were analyzed with a certain time lag, we would probably achieve the expected significance of these variables. For this reason, we modified our model by including the lagged values of these variables, which led us to conclude that only the GDP growth is a statistically significant determinant of non-performing loans. Thus, we have obtained evidence that changes in economic growth negatively affects non-performing loans, but with some delay. Such results are in line with those of Beck et al. (2013).

6. Long-run relationship between non-performing loans and macroeconomic variables

As empirical literature suggests that non-performing loans can follow a unit root process and may be cointegrated with macroeconomic variables (Rinaldi and Sanchis-Arellano, 2006), in this part of the paper, we investigate the integrative features of non-performing loans, GDP, inflation and unemployment, which implies determining their (non) stationarity and the possible cointegration of non-performing loans with these macroeconomic variables.

The first step in evaluating the existence of a cointegrated system is testing the stationarity of the selected variables. According to Dimitrios and Hall (2007), in

stationary time series, shocks are temporary and their effects will be eliminated over time as the series returns to its long-run average value. Namely, when using panel unit root tests in EViews, the null hypothesis of the presence of a unit root is tested, which means the series is non-stationary, as opposed to the alternative hypothesis of stationarity. An exception is the Hadri (Hadri, 2000) unit root test, where the hypotheses are reversed, that is, the null hypothesis of stationarity of the series is tested, and the alternative implies the presence of a unit root, i.e. non-stationary.

In the case of a non-stationary series, there are mechanisms for transforming the series into stationary. Some of these techniques are the following:

1. Differencing - we distinguish between successive observations. Practically from the existing Z_t series, we are constructing a new series:

$$Y_i = Z_i - Z_{i-1}$$

The differenced series will contain one observation less than the original data. Usually, taking the first difference is sufficient and this can help stabilize the average of the time series by removing changes in the time series at level, thereby eliminating the trend or seasonal character.

2. Logarithmic transformation - allows the time series' variance to be stabilized, if it is not constant.

Most macroeconomic variables have a trend and therefore, in many cases are unstable. In such cases, the regression procedure using the ordinary least squares (OLS) method can easily lead to wrong conclusions. Usually, although the variables are not related, high values of the coefficient of determination are obtained. For this reason, in the following part of the paper, we conducted six-panel tests on the presence of a unit root in the series of nonperforming loans, GDP, inflation and unemployment: Levin et al. (2002), Breitung (2000), Hadri (2000), Harris and Tzavalis (1999), Im et al. (2003) and Maddala and Wu (1999). We confirm the (non) stationarity at the significance level of 5%.

The results suggest that the selected determinants have a different degree of integration, i.e. non-performing loans are integrated of second-order, the series of GDP and inflation become stationary after their first difference, while unemployment is non-stationary at level, but becomes stationary only after differencing it twice. Having these results in mind, we proceed to the cointegration tests.

The tests for the cointegration of variables precede the estimation of any long-run model. The interest in testing for the existence of cointegration is basically related to the problem of spurious regressions, which exists only in the case of non-stationarity. Generally, many series in macroeconomics and finance are non-stationary, which can lead to analyzing "spurious regressions" unless we consider their non-stationary. If we regress a variable containing a trend to one or more other trend variables, we often get significant coefficients, but there is essentially no logical explanation or economic significance between them. Common symptoms of a spurious regression are a high determination coefficient - R_2, which indicates the extent to which the overall variations in the dependent variable are explained by the model, furthermore, high t-values

but low DW - Durbin Watson test statistics for autocorrelation in the residuals. The most common indication of a spurious regression is the low Durbin-Watson statistic. According to Granger and Newbold (1974), in order to suspect for the presence of spurious regression, a rule of thumb is $R^2 > d$, i.e. the determination coefficient to be higher than the Durbin Watson test statistic. However, such a series can be successfully modeled if there is a long-run relationship between them. The integration between two or more time-series indicates that there is a long-run, equilibrium relationship between them. According to Kjosevski (2016), the concept of cointegration implies that despite the stochastic movement of variables, a stable long run relationship between them can be observed. Finally, cointegration is a powerful tool for detecting the presence of certain economic structures.

Various cointegration tests can be applied to panel data, largely based on Engle and Granger's cointegration methodology. The Engle and Granger (1987) cointegration test is based on the investigation of the residuals from a spurious regression, using integrated variables of order one, I (1). If the variables are cointegrated, the residuals should be I (0), and if no cointegration exists, the residuals will also be I (1). In this paper, Pedroni's and Cao's panel cointegration tests are being applied. Pedroni (1997, 1999 and 2000) proposed seven-panel data cointegration tests. The good features of these tests are the fact that they allow multiple regressors, the cointegration vector to vary between the different parts of the panel and heterogeneity in cross-sectional errors. We use the "within-dimension" and "between-dimension" ADF and PP test statistics because Pedroni believes that in small-time samples, as is the case, they have the best properties. Pedroni tests are based on Engle and Granger's methodology, where for each cross-section, the dependent variable is regressed on the independent variables, $y_{it} = \alpha_i + \gamma_i t + \beta X_{it} + \varepsilon_{it}$. Next, it examines the stationarity of ε_{it} using a technique similar to the Dickey-Fuller or Philips-Peron test. The difference between "within-dimension" and "between-dimension" statistics is that in the first one, the alternative hypothesis is homogeneous, that is, $\rho_i = \rho < 1$, for all i, while in the other there is a heterogeneous alternative hypothesis, ie$\rho_i < 1$. All of Pedroni's tests are one-sided, with all statistics (with the exception of v-test statistic) having a critical value of - 1.64, which means that if the value of the test statistic is greater than - 1.64, it means rejecting the null hypothesis of lack of cointegration.

Cao (1999), in his paper, proposes two tests with the null hypothesis for the lack of panel data cointegration. One is the Dicky Fuller type of test and the other is the augmented Dicky Fuller. The Cao test imposes homogeneous cointegration vectors and AR coefficients but does not allow for more exogenous variables in the cointegration vector.

Four of Pedroni's test statistics suggest that there is a long-run relationship between the variables analyzed, at the significance level of 1% and 5%. Moreover, the Cao test fails to reject the alternative hypothesis for a cointegration relationship between non-performing loans, GDP, inflation, and unemployment.

Therefore, we proceed to the estimation of the long-run relationship between non-performing loans and macroeconomic variables. We use the panel estimator proposed by Kao and Chiang (1996), panel dynamic ordinary least squares or DOLS. The DOLS estimator is chosen because even in the presence of endogenous regressors, it gives unbiased and efficient estimates of the long-run relationship.

The results obtained with the weighted panel DOLS show significance of GDP, inflation, and unemployment at the 5% significance level. These are the estimated long-run coefficients and the interpretation would be as follows: the negative GDP coefficient means that if economic growth were to increase by 1%, then non-performing loans would decrease by 1.28%. Furthermore, if inflation increases by 1%, this would lead to a smaller reduction of credit risk by 0.62%, and if unemployment increases by 1%, then this would be reflected in the increase of non-performing loans by 1.01%. Such results are in line with economic theory. In fact, a negative relationship between non-performing loans with GDP growth and inflation, but a positive one with the unemployment rate is also proved by Petkovski, M, Kjosevski, J. et al. (2018) in their research on the Czech banking system.

In addition to the weighted panel DOLS, in order to check the robustness of our results we run other alternative methods, such as the group DOLS estimator, along with the panel and group FMOLS. The estimated long-run relationship between non-performing loans and macroeconomic variables (GDP, inflation and unemployment) exhibited solid robustness. Namely, the results from the panel and group FMOLS show the same results as the weighted panel DOLS, in terms of the significance and sign of the variables' coefficients. Only when using the group DOLS estimator, inflation becomes insignificant and changes its sign. However, since the majority of the applied methods give the same results, we can conclude that the results obtained for the long-run relationship are robust.

Table 2. Estimated long-run coefficients

Dependent Variable: NPL
Method: Panel Dynamic Least Squares (DOLS)
Date: 10/03/19 Time: 11:53
Sample (adjusted): 2009 2017
Periods included: 9
Cross-sections included: 5
Total panel (balanced) observations: 45
Panel method: Weighted estimation
Cointegrating equation deterministics: C
Automatic leads and lags specification (based on AIC criterion, max=*)
Long-run variance weights (Bartlett kernel, Newey-West fixed bandwidth)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP	-1.282207	0.418073	-3.066946	0.0056
INF	-0.624719	0.253484	-2.464532	0.0220
UN	1.012412	0.212327	4.768171	0.0001

R-squared	0.844815	Mean dependent var	14.37760
Adjusted R-squared	0.689630	S.D. dependent var	4.840797
S.E. of regression	2.696851	Sum squared resid	160.0062
Long-run variance	3.098935		

Source: Author's calculations.

The findings obtained for the long-run relationship between non-performing loans and the macroeconomic variables provide evidence that the deterioration of the macroeconomic environment, manifested as slower economic growth, higher unemployment, and falling prices, is associated with problems in servicing due liabilities, reflecting an increase in credit risk. On the other hand, in positive macroeconomic conditions, the level of non-performing loans is low, as was the case in the wake of the 2008 crisis.

The estimated long-run coefficients indicate that if the performance of an economy improves, or GDP grows, citizens have higher income and, consequently, they are able to meet their due obligations at the time they are due. Moreover, the unemployment rate decreases and this is closely related to the performance of the banking system: people are more likely to cooperate with banks, open transaction accounts, use their services, and have a higher potential to meet due liabilities. Increased income, in the long run, means higher consumption and investment, so the likelihood of credit risk realization is lower. Inflation growth, on the one hand, diminishes the real value of debt which facilitates its return, but also as the Phillips curve implies, higher inflation is associated with lower unemployment Nkusu (2011) and lower unemployment rate, as stated above, has a positive impact on the ability of debtors to meet their obligations.

Such interactions in the long run, are important in designing macroeconomic policies and strategies for resolving non-performing loans, in order to avoid credit risk materialization as much as possible.

7. Short-run relationship between non-performing loans and macroeconomic variables

The presence of cointegration is a necessary and sufficient precondition for estimating the long-run and short-run coefficients of the analyzed variables. In this part of the paper, our attention will be focused on the short-run dynamics of non-performing loans caused by macroeconomics in the SEE countries.

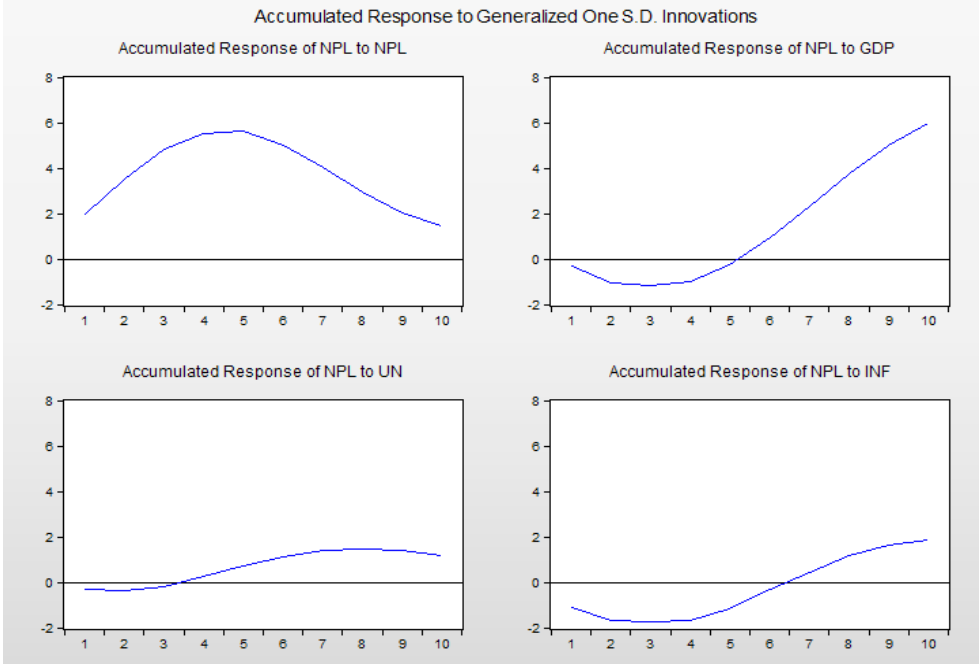
Therefore, we proceed to estimate a VECM, in order to check for the short-run causality. However, prior to the estimation of a VECM, the Granger causality test is conducted to estimate the cause-and-effect relationship between the variables. The results for Granger causality reveal a unidirectional causality running from GDP and inflation rate to nonperforming loans, at the 1% level of significance and a unidirectional causality from the unemployment rate to nonperforming loans, at 10% level of significance. Later, based on the optimal lag length criteria, we proceed to estimation of a VECM with two lags. The residuals of the estimated VECM are normal and not serially correlated, which suggests that the model is good. The adjusted coefficient of determination is 47.4%, indicating that a large part of the variations in the level of credit risk are explained by the selected macroeconomic variables.

The dynamics of the estimated VECM can be visualized with impulse response diagrams, which follow below. Namely, the interactions between variables are

examined based on generalized impulse responses, where the order of the variables isn't important. The results of the IRF show how nonperforming loans (NPL) respond to shocks in the macroeconomic variables and non-performing loans themselves.

The first graph provides evidence of the tendency for nonperforming loans to persist for a longer period in banks' balance sheets, which is why they face a long process of dealing with them. On the other hand, the responses of non-performing loans to a one standard deviation shock in GDP and inflation are negative, with some stabilization after the second year, which later is positive and permanent. On the contrary, a one standard deviation shock in unemployment, has a negative response of small magnitude of NPLS, but turns positive after the second year.

Figure 3. Accumulated impulse responses



Source: Author's calculations.

Furthermore, we compute the forecast error variance decomposition (FEVD) over the horizon of 10 years, in order to determine which of the analyzed macroeconomic variables has a dominant contribution to the change in non-performing loans. According to Blazheska (2017), the variance decomposition shows how much of the variability in a particular variable can be explained by the shocks that are characteristic to the variable itself, and how much by those characteristic to the other variables.

The results indicate that over a period of 10 years, over 55% of the variance in non-performing loans largely consists of volatility and shocks affecting non-performing loans themselves, while changes in other variables account for about 44% of the variance in non-performing loans. The forecast error variance decomposition for NPL is mostly

attributed to itself in the first year, whereas later, GDP has the largest contribution, accounting for between 3% and 33% of the forecast error variance, with its share increasing as forecast horizon extends. In contrast, inflation and unemployment have a much smaller contribution to explaining non-performing loans, i.e. only 5.35% and 5.96% of the variance in non-performing loans can be explained by the inflation rate and the unemployment rate respectively, over the horizon of 10 years.

Finally, we estimate the short-run model, by applying Blundell and Bond's (2000) system GMM, expressed with the following equation:

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Table 3. Estimated short-run coefficients

Dependent Variable: D(NPL)
Method: Panel Generalized Method of Moments
Date: 10/09/19 Time: 13:38
Sample (adjusted): 2011 2017
Periods included: 7
Cross-sections included: 5
Total panel (balanced) observations: 35
2SLS instrument weighting matrix
D(NPL) = C(1)*(NPL(-1) - 1.484484209*GDP(-1) + 0.324803349996*UN(-1) - 0.594482719908*INF(-1) - 18.5723310223) + C(2)*D(NPL(-1)) + C(3)*D(NPL(-2)) + C(4)*D(GDP(-1)) + C(5)*D(GDP(-2)) + C(6)*D(UN(-1)) + C(7)*D(UN(-2)) + C(8)*D(INF(-1)) + C(9)*D(INF(-2)) + C(10)
Instrument specification: C D(NPL) D(NPL(-1)) D(NPL(-2)) D(GDP) D(GDP(-1)) D(GDP(-2)) D(INF) D(INF(-1)) D(INF(-2)) D(UN) D(UN(-1)) D(UN(-2))
Constant added to instrument list

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.443648	0.131546	-3.372573	0.0024
C(2)	0.206855	0.176967	1.168888	0.2535
C(3)	0.463888	0.161454	2.873195	0.0082
C(4)	-0.960828	0.252133	-3.810805	0.0008
C(5)	-0.258887	0.163655	-1.581902	0.1262
C(6)	0.142033	0.365412	0.388694	0.7008
C(7)	0.421810	0.377070	1.118652	0.2739
C(8)	-0.122485	0.269875	-0.453859	0.6538
C(9)	-0.005883	0.210480	-0.027949	0.9779
C(10)	-0.806030	0.435389	-1.851288	0.0760

R-squared	0.557526	Mean dependent var	-0.689416
Adjusted R-squared	0.398236	S.D. dependent var	2.687118
S.E. of regression	2.084490	Sum squared resid	108.6275
Durbin-Watson stat	1.931208	J-statistic	17.24545
Instrument rank	13	Prob(J-statistic)	0.000629

Source: Author's calculations

The error correction mechanism, C(1), which shows the speed of adjustment of non-performing loans to their long-run equilibrium level, is negative and statistically significant at the 1% significance level. This practically confirms the long-run relationship between the selected macroeconomic variables and non-performing loans. Thus, about 44% of the imbalances in the previous period (year), caused by short-term shocks in macroeconomics, converge to the long-run equilibrium in the current period. In other words, the analyzed variables in the model manage to return to their stable, long-run equilibrium relationship in a relatively short period, despite their short-term shifts.

The findings obtained from the short-run model are similar to the long-run dynamics. Both, in the long-run, and the short-run, there is a statistically significant inverse relationship of GDP with non-performing loans, with approximately the same coefficient value. The coefficient obtained in the short-run indicates that a 1% increase in GDP would cause a nearly equal fall in non-performing loans, more precisely a drop of 0.96%. However, unlike the long-run model, unemployment and inflation proved to be statistically insignificant determinants, although they have the same signs as in the long-run.

Lastly, we apply the Wald test to find out if the parameters of the explanatory variables are significant. The obtained results suggest that there is a short-term impact of macroeconomic variables on nonperforming loans, at the 1% significance level.

8. Conclusion

In the aftermath of the global financial crisis, the problem of rising non-performing loans was a major challenge faced by most countries, with this problem being more pronounced in Southeast European countries. For this reason, this study aimed to examine the relationship between certain indicators of financial stability and macroeconomic variables with non-performing loans in selected SEE countries based on annual data from 2008 to 2017 using the one-step GMM model.

The results obtained show that profitability has a negative and statistically significant effect on non-performing loans, while credit growth and capitalization rate have a positive and statistically significant impact on the non-performing loan portfolio. The model confirms the previously expected feature of non-performing loans to persist in the bank's balance sheets, which justifies the dynamic specification of the model.

In terms of long-run dynamics, the results suggest that there is a negative relationship between economic growth and inflation rate with the growth of non-performing loans. On the other hand, the unemployment rate has a positive effect on non-performing loans in the long run. Such results are robust when using the panel and group estimator of fully modified ordinary least squares (FMOLS), whereas when using the group DOLS estimator, the inflation rate becomes insignificant and changes its sign. This confirms the theoretical conclusion that the deterioration of the macroeconomic environment, expressed through reduced GDP growth, increased unemployment, and a decline in the general price level, contributes to the reduced creditworthiness of debtors, which is ultimately manifested in increased credit risk. In the short run, only economic growth has a negative impact on non-performing loans.

The dynamic adjustment coefficient in the short-run is negative and statistically significant, thus confirming the long-run relationship between macroeconomic variables and non-performing loans. This shows that the imbalance caused by short-term shocks returns to its long-run equilibrium for a relatively short time (over a period of one year).

The analysis of the feedback effects between the NPLs and economic activity confirms the strong macro-financial linkages in the SEE countries.The results from the conducted (FEVD) forecast error variance decomposition show that GDP has a dominant contribution to the change in non-performing loans, while the Granger causality test confirms the uni-directional causality from GDP ratio and inflation rate to non-performing loans, confirming that NPLs respond to macroeconomic conditions. Therefore, the ground condition for sustainable growth is a sound and resilient banking system.

In summary, the conclusions of this paper suggest that the basic prerequisite for the management of non-performing loans is the existence of macroeconomic stability and sound policies that are the starting point for a stable environment for the operation of banks and other economic entities. But this, itself, is not enough if there are inadequate risk management and weaknesses in the credit process, i.e. in the process of banks' assessment of creditworthiness. Namely, the risk of creating non-performing loans is inevitable, but understanding the factors that drive it is of crucial importance in order to prevent its sudden rise and spill over into the real economy. Therefore, regulators should place greater emphasis on banks' systems and procedures for risk management, possibly by introducing some borrower-based measures, in order to prevent future financial instability.

As a guide for future research on this topic, loan loss provisions or default rates, in addition to the share of non-performing loans can be used as a measure of credit risk. Moreover, different econometric techniques, such as the System Generalized Two-Step Moment Method and the Johansen Cointegration Technique can be applied in the future. Also, it would be beneficial to analyze these countries at a bank level and break down non-performing loans by sector. Lastly, if more data becomes available, the impact of the substantial write-offs in the SEE countries on the dynamics of the NPLs should be taken into account in future studies.

References

Abebrese, G.O., Pickson, R.B. and Opare, E. (2016) "Macroeconomic Factors and the Performance of Loans of Commercial Banks in Ghana: A Case Study of HFC Bank". *European Journal of Economics, Finance and Administrative Sciences*, 87, pp. 38-46.

Anjom, W. and Karim, A.M. (2016) "Relationship between non-performing loans and macroeconomic factors (with specific factors: a case study on loan portfolios- SAARC countries perspective)". *Asia Pacific Journals of Finance and Risk Management*, 15(3), pp. 84-103.

Beck, R., Jakubik, P. and Piloiu, A. (2013) "Non-performing Loans What matters in addition to the Economic cycle?". Working paper series [1515], European Central Bank, Frankfurt, February.

Berger, A. and DeYoung, R. (1997) „Problem Loans and Cost Efficiency in Commercial Banks“. *Journal of Banking and Finance*, 21, pp. 849–870.

Blazheska, A. (2017), „Analysis of the impact of operational risk on the business success of life insurance companies in the Republic of Macedonia“, available at: http://www.aso.mk/dokumenti/trudovi/1.AngelaBlazheska_AnalizaNaVlijanietoNaOperativniotRizik.pdf

Blundell, R. and Bond, S. (2000) “GMM estimation with persistent panel data: an application to production functions“. *Econometric reviews*, 19 (3), pp.321-340.

Bošnjak, A., Hassan, A. and James, K. (2017) “Analysis of the Banking Sector Performance in Bosnia and Herzegovina, Montenegro and Serbia Before and After the Global Financial Crisis“, *Economics*, 5(2), pp. 83-101.

Bucevska, V. (2011), “An analysis of financial crisis by an early warning system model: The case of the EU candidate countries“. *Business and Economic Horizons*, 4(1), pp. 13-26.

Dimitrios, A. and Hall, S.G. (2007) *Applied Econometrics A Modern Approach*, Palgrave Macmillan, New York, NY.

Dushku, E. and Kota, V. (2013) “The Financial Model for Albania: A panel data approach“. Working paper [15(54)], Bank of Albania, Tirana.

Espinoza, R. and Prasad, A. (2010) “Nonperforming Loans in the GCC Banking System and their Macroeconomic Effects“. IMF Working paper [10/224], International Monetary Fund, Washington, D.C.

Granger, C.W.J. and Newbold, P. (1974) “Spurious regression in econometrics“. *Journal of Econometrics*, 2, pp. 111-20.

Hyndman, R.J. and Athanasopoulos, G. (2018) “Forecasting: Principles and Practice“. Second edition, OTexts: Melbourne, Australia.

Jimenez, G. and Saurina, J. (2006) “Credit Cycles, Credit Risk, and Prudential Regulation“. *International Journal of Central Banking*, 2(2), pp. 65-98.

Jordan, A. and Tucker, C. (2013) “Assessing the Impact of Nonperforming Loans on Economic Growth in The Bahamas“. *Monetaria*, Vol. XXXV, Issue 2, July-December, pp. 403-436.

Judson, R. A. and Owen, A. L. (1999) “Estimating dynamic panel data models: A guide for macroeconomics“. *Economic Letters*, 65(1), pp. 9–15.

Kao, C. and Chiang, M.H. (2000) “On the estimation and inference of a cointegrated regression in panel data“. *Advances in Econometrics*, 15, pp. 179-222.

Keeton W.R. and Morris, C.S. (1987) "Why Do Banks' Loan Losses Differ". *Economic Review*, pp.3-21.

Klein, N. (2013) "Non-Performing Loans in CESEE: Determinants and Impact on Macroeconomic Performance". IMF Working Paper 13/72, International Monetary Fund, Washington, D.C.

Kjosevki, J. (2016) "Bank specific and macroeconomic determinants of non-performing loans in the Republic of Macedonia: Comparative analysis of corporate and household loans", available at: http://www.nbrm.mk/WBStorage/Files/WebBuilder_Bankarski_specificni_makroekonomski_determinanti_nefukcionalnite_krediti_RM_Jordan_Kosevski.pdf.

Lee, J. and Rosenkranz, P. (2019) "Nonperforming Loans in Asia: Determinants and Macrofinancial linkages". ADB Economics Working Paper Series [574], Asian Development Bank, Mandaluyong, March.

Louzis, D.P., Vouldis, A.T. and Metaxas V. L. (2011) "Macroeconomic and Bank Specific Determinants of Nonperforming Loans in Greece: A Comparative Study of Mortgage, Business and Consumer Loan Portfolios". *Journal of Banking and Finance*, 36(4), pp. 1012-1027.

Mazreku, I., Morina, F., Misiri, V., Spiteri, J. and Grima, S. (2018) "Determinants of the Level of Non-Performing Loans in Commercial Banks of Transition Countries". *European Research Studies Journal*, 21, 3, pp.3-13.

Nikolov, M. and Popovska-Kamnar, N. (2016) "Determinants of NPL growth in Macedonia". *Journal of Contemporary Economic and Business Issues*, 3(2), pp. 5-18.

Pesaran, M.H. and Shin, Y. (1998) "Generalized Impulse Response Analysis in Linear Multivariate Models". *Economics Letters*, 58(1), pp.17-29.

Petkovski, M., Kjosevki, J. and Jovanovski, K. (2018) "Empirical Panel Analysis of Non-Performing Loans in the Czech Republic. What are their Determinants and How Strong is Their Impact on the Real Economy". *Finance aúvěr-Czech Journal of Economics and Finance*, 68(5), pp. 460-480.

Rime, B. (2000) "Capital requirements and bank behaviour: Empirical evidence for Switzerland". *Journal of Banking and Finance*, 25(4), pp. 789-805.

Rinaldi, L. and Arellano, S. (2006) "Household debt sustainability: What explains household non-performing loans? An empirical analysis". Working paper No.570, ECB, Frankfurt, January.

Salas, V. and Saurina, J. (2002) "Credit Risk in Two Institutional Regimes: Spanish Commercial and Savings Banks". *Journal of Financial Services Research*, 22(3), pp. 203–224.

Swamy, V. (2012) “Impact of Macroeconomic and Endogenous Factors on Non-Performing Bank Assets“, *International Journal of Banking and Finance*, 9(1), pp.27-47.

Škarica, B. (2014) “Determinants of non-performing loans in Central and Eastern European countries“. *Financial Theory and Practice*, 38(1), pp. 37-59.

Vardar, G. and Özgüler, I. C. (2015) “Short Term and Long Term Linkages among Nonperforming Loans, Macroeconomic and Bank-Specific Factors: An Empirical Analysis for Turkey“. *Ege Academic Review*, 15(3), pp.313-325.

Zelenovic, V., Vitomir, J. and Radovic, M. (2016) “Analysis of NPL in the Republic of Serbia and Selected Countries of South-Western Balkans“. *Journal of US-China Public Administration*, 13(7), pp.448.